Imperfect Competition in Financial Markets and Capital Controls: A Model and a Test.

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Abstract

This paper explores the implications of financial repression, specifically, imperfect competition in the financial sector and capital controls for equilibrium interest rates and current account imbalances; and the implications of liberalization. I find that (1) interest differentials between home and foreign markets exist and are higher the fewer the number of domestic financial institutions (2) liberalization of the domestic financial sector - i.e. increasing the number of players - exacerbates current account imbalances in growing economies and reduces revenues from repression (3) revenues from financial repression decline when capital controls become porous (which may be a consequnce of trade liberalization), making liberalization of domestic financial sector more palatable to the domestic governments. An empirical exercise validates several predictions of the model.

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1 Introduction

Financial repression refers to the existence of restrictions on activity of the financial sector, including but not limited to interest ceilings, excessive reserve requirements, credit allocation ceilings or direction of credit to priority sectors, entry barriers and controls on the capital account that reduce efficiency of the financial system (McKinnon, 1973; Shaw 1973). Many developing countries impose one or more such controls on their financial systems. Studies on financial repression have focussed on identifying incentives for repression (tax revenues being the most important - Jinjarak (2006) updates Giovannini and DeMelo (1993) estimates of government revenues from repression and finds mean revenue among 62 developing countries to be 4 per cent of GDP in recent years), on its implications for growth (Epsinosa and Yip, 1996; Eichengreen, 2001; Gourinchas and Jeanne 2006; Henry, 2007), exchange rate management (Kletzer and Kohli, 2001; Bernhard and Leblang, 1999) and crises. The objective of this paper is twofold: (a) to explore the implications of financial repression, specifically, imperfect competition in the financial sector and capital controls, on the equilibrium interest rates and current account imbalances, and (b) to explore the impact of financial openness on the revenues from repression, thus explaining the negative association between these on the one hand, and between trade openness and financial openness on the other(Jinjarak, 2006; Aizenman, 2008).

Several studies have documented the existence of interest differentials, particularly in emerging markets (Pasricha, 2008; Vieria, 2003; Chinn and Meredith, 2004; Chinn, 2006, Singh and Banerjee, 2006). This paper models an economy with monopolistic and oligopolistic financial markets and controls on the capital account and finds that even in a world free of transactions costs and counterparty risks, capital controls alone are not sufficient to cause interest rates differentials to exist in equilibrium. The structure of domestic markets plays a crucial role in determining the size of differentials. These predictions are validated by data on low and middle income countries (Table 1). An index of bank concentration, defined as the percentage of banking sector assets held by the three largest banks, is significant in explaining absolute deviations between home and foreign interest rates, after controlling for capital account openness. The greater the concentration in the banking sector, the larger the absolute deviations between the home and foreign interest rates. The model described in this paper explains this relationship as a consequence of the monopoly power of the domestic financial institutions. The implication is that liberalization of the domestic financial sector can act as a substitute to capital account openness, in this respect.

If the governments are able to tax away a part of the profits of the financial sector (which may be the reason they restrict competition in this sector), then the paper also shows that liberalizing capital controls and liberalizing domestic financial sector may be substitutable policies in so far as their impact on government revenues is concerned. Trade openness, which increases avenues for evasion of capital controls through misinvoicing [1] can also undermine the rationale for financial repression, thus making financial liberalization - both domestic and foreign - more palatable. Aizenman (2008) models this reduced incentive for repression as an increase in cost of monitoring, while in an extension of my model that explicitly allows

[1] Prasad and Rajan (2008), Claessens and Naude (1993), Boyce and Ndikumana (2001), Collier et al. (2001).

for trade in goods, trade openness will reduce the revenues collected because of the erosion of monopoly power of the domestic financial system.

2 Monopoly in Domestic Financial Sector

A small, partially open economy has two generations of agents at any point in time, each with a two-period life. An agent born in (young in) period t has income Y_t^Y and faces income uncertainty in the old age. With probability $\pi(1)$ she has $Y_{t+1}^o(1) = Y_t^Y(1+\epsilon)$ and with probability $\pi(2)$, she has $Y_{t+1}^o(2) = Y_t^Y(1-\epsilon)$. ϵ is a known positive number and represents the ideosyncratic shock to second period income. Population of young and old at any time is constant and normalized to 1. The aggregate income of the old at time $t+1$ is then Y_{t+1}^o which equals $\pi(1)Y_t^Y(1+\epsilon) + \pi(2)Y_t^Y(1-\epsilon) = Y_t^Y[1 + (\pi(1) - \pi(2))\epsilon]$. $(\pi(1) - \pi(2))\epsilon$ then is the macroeconomic shock. In the discussion that follows, I assume $\pi(1) = \pi(2)$, unless otherwise specified. The economy is assumed to be growing at a rate g, so that the young of period $t+1$ have an income $Y_t^Y(1+g)$. It is straightforward to show that g is also the growth rate of the older generation's income[2].

Capital controls prevent the agents from accessing foreign markets for risk-free bonds, the only asset available, but they can borrow from or lend to the domestic financial institution, at the home rate of interest, r_t. This assumption reflects the reality that while governments may

[2]When the young of period t are old in period $t+1$, a proportion $\pi(1)$ will realize the positive shock and a proportion $\pi(2)$ will realize the negative shock. Since the population of each is normalized to 1, the total income of the old in period $t+1$ equals $Y_{t+1}^o = Y_t^Y 1 + (\pi(1) - \pi(2))\epsilon = Y_t^o(1+g)$.

impose capital controls on its residents, rarely do countries have balanced current accounts. Home lending is also risk-free.

The young agent at time t faces the following optimization problem:

$$Max\ EU = u(C_t^Y) + \beta\left[\pi(1)u(C_{t+1}^o(1)) + \pi(2)u(C_{t+1}^o(2))\right], \quad u' > 0,\ u'' < 0$$

s.t.

$$\begin{aligned} C_t^Y &= Y_t^Y - B_t^Y \geq 0 \qquad (1) \\ C_{t+1}^o(s) &= Y_{t+1}^o(s) + (1+r_t)B_t^Y \geq 0; \quad s = 1,2 \end{aligned}$$

Assume that $u(c) = log(c)$. Given the home interest rate in period t, r_t, the young agent's demand for Bonds, B_t^Y (which may be negative) is given by the solution to:

$$\begin{aligned} S(B_t^Y, r_t) &= -u'(Y_t^Y - B_t^Y) \\ &\quad + \beta(1+r_t)\pi(1)u'(Y_t^Y(1+\epsilon) + (1+r_t)B_t^Y) \\ &\quad + \beta(1+r_t)\pi(2)u'(Y_t^Y(1-\epsilon) + (1+r_t)B_t^Y) \\ &= 0 \qquad (2) \end{aligned}$$

Note that $S_{B_t^Y} < 0$ and $S_{r_t} \lesseqgtr 0$ so that $\frac{\delta B_t^Y}{\delta r_t} \lesseqgtr 0$, i.e. savings function may be backward bending at very high interest rates or large savings. The above equation gives us the demand for bonds (demand for loans when negative) as an implicit function of the domestic interest rate, with first and second period incomes, probability of each state and discount factor as parameters. The demand for bonds (or the supply of savings) increases with the first period income and falls with the second period expected income and with the discount factor, β.

While a larger adverse macroeconomic shock (larger $\pi(2)$ or larger ϵ when $\pi(1) < \pi(2)$) always increases savings (figure 1), the impact of a pure ideosyncratic shock ϵ when $\pi(1) = \pi(2)$ is more nuanced and depends on the utility function under consideration. For the log utility function assumed here, when ϵ is small to begin with, small increases in uncertainty may reduce the supply of savings. A higher ϵ means a lower marginal utility in the good state and a higher marginal utility in the bad state, other things being equal. The agent's optimality condition is that the expected marginal utility from period 2 (weighted by $\beta(1+r)$) equal period 1's marginal utility. When ϵ is small to begin with, the consumptions in the two states in period two are not too different and when epsilon increases, if the loss in marginal utility from higher consumtion in good state is higher than the gain in marginal utility from lower consumtion in bad state[3], the agent will compensate by increasing period 1 consumption by reducing saving. As figure 2 below shows, for small increases in ϵ beginning from $\epsilon = 0$, the supply of savings first shifts down and starts shifting up only after $\epsilon > 0.1$.

The financial institution is a Stackelberg leader and a monopolistic supplier of financial servies to the agents. He takes the agents' demand function for bonds and uses it to set domestic interest rate that maximizes his profits in each period. He can borrow or lend also at the foreign risk free interest rate, and his total exposure to foreign markets at time t is just the young generation's saving. The financial institution's period t optimization problem is given by:

$$\Pi_t = -(r_t - r_t^*)B_t^Y$$

[3] and this will happen if the utility function is very curved.

s.t.

$$S(B_t^Y, r_t) = 0$$

$$r_t \geq 0$$

Its optimization conditions reduce to:

$$r_t - r_t^* = B_t^Y \frac{S_{B_t^Y}}{S_{r_t}} = \frac{-B_t^Y}{B_{tr}^Y} \tag{3}$$

The two equations, 2 and 3 give the equilibrium values of domestic interest rate and saving in period t. The monopoly power of the domestic financial institution means that there is a wedge between domestic and foreign interest rates that persists in equlibrium. This interest differential increases with the patience of the young generation, i.e. the value it puts on the tomorrow's consumption, β. The higher the β, the more the young agent values tomorrow's consumption therefore the less elastic the demand for bonds, thus increasing the financial intermediary's monopoly power (see figure 3 for an illustrative example). The interest differential does not change with the growth rate for the log utility function, unless the size of the shock varies with the growth rate (figure 4).

Domestic interest rate increases with foreign interest rate, although the relationship is not linear. Domestic rate is lower than the foreign rate when the young generation in period t has positive savings and it is higher than the foreign interest rate when young generation is a net borrower from the rest of the world in period t. In either case, monopoly profits are positive. Governments that are able to tax these profits more easily than incomes may find it optimal to preserve monopoly profits by restricting competition in the domestic economy and by imposing capital controls. Note that this model can also be used to explain why informal sector interest rates are higher than formal sector rates in developing countries where formal sector has limited access.

Depending on other parameter values, for low values of foreign interest rate, equlibrium real interest rate in the domestic economy may be zero or negative (it has been constrained in the figures to be at least zero). Savings by young generation may be positive even with negative real interest rates.

The Current Account (CA) balance in period t is the difference between the young generation's saving and the old generation's dissaving, and if the two generations are same in all respects, then equals zero. The link between the interest differential and CA balance is therefore, broken. A positive interest differential between home and abroad need not be associated with capital inflows, but can be associated with no net flows or with capital outflows (CA surplus). A positive interest differential ($r_t - r_t^* > 0$) is associated with young generation's borrowing. The CA balance increases with the growth rate of the economy, as the younger generation saves more than the older generation dissaves (figure 4). As long as the economy has a positive growth rate, the current account balance increases with the patience parameter, β and falls with the macroeconomic shock. The larger the reduction in old age's expected income, the greater the saving of the young, and the higher the current account surplus if the incomes of the young are growing. Growing economies that see their social security systems become inadequate as governments withdraw from the economy or that have a disproportionately large share of higher income opportunities available to the young could see larger surpluses in their external accounts. This is consistent with the evidence provided in Chamon and Prasad (2007) and Chou, Liu and Hammitt (2003). The former explain the increase in China's saving rate for cohorts in their 40's and 50's in the beginning of the 1990's as a result of the increase in prospects of incurring lumpy and uncertain health expenditures with few working years left to benefit from the reforms. They estimate an increase in the health and education expenditures from 2 percent of household consumption expenditures in 1995 to 14 per cent in 2005. Chou, Liu and Hammitt (2003) estimate that the universalization of health insurance reduced Taiwan's savings rate by 2.5 per cent.

3 Oligopoly in Domestic Financial Markets

In this section, I assume that the government allows limited liberalisation of the domestic financial sector, so that the number of financial intermediaries in the domestic sector exceeds 1. Assume that post-liberalisation, the domestic market becomes a financial oligopoly, with a limited number of cournot oligopolists who take the domestic demand (for loans or bonds, as the case maybe) as given and compete on quantities. The young agent's maximization problem at time t is the same as in the previous section, equations (1), with B_t^Y reinterpreted as the sum of agent lending to all financial institutions. Agent optimization yields the familiar first order necessary condition, the market demand for bonds given by equation (2).

Each financial institution takes the market demand and the other financial institutions' quantity at time t as given and maximizes its own profit, which gives the optimization problem:

$$\Pi_{jt} = -(r_t - r_t^*)b_{tj}^Y$$

s.t.

$$S(B_t^Y, r_t) = 0$$
$$B_t^Y = \sum_{j=1}^{n} b_{tj}^Y$$

The j_{th} financial institution's optimization conditions reduce to:

$$r_t - r_t^* = b_{tj}^Y \frac{S_{b_{tj}^Y}}{S_{r_t}} = \frac{-b_{tj}^Y}{B_{tr}^Y} \quad (4)$$

Together, these imply that the total market demand for bonds (which may be negative) is, as usual, split equally between the n intermediaries in equilibrium. That is, $b_{tj}^Y = \frac{B_t^Y}{n}$. The home interest rate and volume of financial transactions are then determined by the solution to:

$$\begin{aligned} f(B_t^Y, r_t) &= \frac{-1}{Y_t^Y - B_t^Y} + \frac{\beta\pi(1)(1+r_t)}{Y_2(1) + (1+r_t)B_t^Y} + \frac{\beta\pi(2)(1+r_t)}{Y_2(2) + (1+r_t)B_t^Y} = 0 \\ r_t &= r_t^* + \frac{-b_{tj}^Y}{B_{tr}^Y} \end{aligned} \quad (5)$$

Comparing the equilibirum conditions for monopoly (3) and oligopoly (5), it is clear that the interest rate differential is lower and volume of transactions higher the larger the number of players in the domestic market. Domestic agent's welfare is unambiguously higher. A government that cares both about the welfare of its agents and its tax revenues may then find it optimal to set a finite limit to the number of financial intermediaries, n. Moreover, if financial depth is related to growth rate of the economy, as previous studies have suggested, then the optimal n will be larger than when financial intermediation activities are not helpful to growth. On the other hand, the larger the constraints on direct-tax raising abilities of the government and the more valuable the public services to the agents, the lower the optimal n.

As far as the impact on current account is concerned, financial liberalisation, even if limited, increases the generational saving/dissaving. Conditional on the CA imbalance being non-zero, financial liberalization thus exacerbates the imbalances in current account (figure 5). This may partly explain the growing current account surpluses in emerging markets in the last decade of liberalization and constitutes and important consideration that has been missing in recent studies on global imbalances. Another important result of this section is that liberalization of domestic financial sector, even when capital controls continue to be effective, leads to lower interest differential between home and abroad. Imperfections in the domestic financial market and capital controls interact to determine the size of interest differentials.

4 Limited access to foreign markets

This section considers the impact of limited capital account liberalization that provides the agents some access to foreign markets. International trade has expanded at a rapid pace in the last two decades and trade can allow a country's residents to evade capital controls through misinvoicing. In an extension of this model that allows for more than one good, such liberalization as considered in this section can be explicitly modeled to result from an expansion of trade.

Assume that the young agent is allowed to borrow and lend upto $\bar{B}$ in the foreign market at the foreign interest rate, r_t^* and must meet any spillover demands for financial intermediation at home, at the home interest rate. $\bar{B}$ then is a metric of openness, with larger values representing greater openness. The agent's optimization problem now is:

$$MaxEU = u(C_t^Y) + \beta\left[\pi(1)u(C_{t+1}^o(1)) + \pi(2)u(C_{t+1}^o(2))\right]$$

s.t.

$$C_t^Y = Y_t^Y - B_t^Y - B_t^* \tag{6}$$

$$C_{t+1}^o(s) = Y_{t+1}^o(s) + (1+r_t)B_t^Y + (1+r_t^*)B_t^*; \quad s = 1,2 \tag{7}$$

$$-\bar{B} \le B_t^* \le \bar{B} \tag{8}$$

Kuhn-Tucker conditions imply that when $r_t = r_t^*$, B^* is strictly between the bounds given by $[-\bar{B}, \bar{B}]$ and total demand for bonds by young at time t is given by the solution to:

$$\begin{aligned} S(B_t, r_t) &= \frac{-1}{Y_t^Y - B_t} + \frac{\beta\pi(1)(1+r_t^*)}{Y_{t+1}^o(1) + (1+r_t^*)B_t} + \frac{\beta\pi(2)(1+r_t^*)}{Y_{t+1}^o(2) + (1+r_t^*)B_t} \\ &= 0 \end{aligned} \tag{9}$$

where $B_t = B_t^* + B_t^Y$. In this case the split between foreign and domestic transactions is indeterminate and we can only determine the net borrowing or lending. Note, however that when $r_t = r_t^*$, the profits of the financial institution(s) are zero, so nothing is lost by assuming that all financial intermediation is done abroad.

When $r_t \neq r_t^*$, the foreign borrowing and lending limit must be fully exhausted. Either $B_t^* = \bar{B}$ or $B_t^* = -\bar{B}$. Lets consider each case in turn:

1. When $B_t^* = \bar{B}$, domestic lending by the young agent (deposits with the domestic financial institution) is given by the solution $\tilde{B}_t^Y$ to:

$$\begin{aligned}\tilde{S}(B_t^Y, r_t) &= \frac{-1}{Y_t^Y - B_t^Y - \bar{B}} + \frac{\beta\pi(1)(1+r_t)}{Y_{t+1}^o(1) + (1+r_t)B_t^Y + (1+r_t^*)\bar{B}} \\ &+ \frac{\beta\pi(2)(1+r_t)}{Y_{t+1}^o(2) + (1+r_t)B_t^Y + (1+r_t^*)\bar{B}} \quad = 0 \qquad (10)\end{aligned}$$

   Lets call this solution $\tilde{\Xi} = (-\bar{B}, \tilde{B}_t^Y)$.

2. When $B^* = -\bar{B}$, domestic borrowing by the young agent is given by the solution, $\hat{B}_t^Y$ to:

$$\begin{aligned}\hat{S}(B_t^Y, r_t) &= \frac{-1}{Y_t^Y - B_t^Y + \bar{B}} + \frac{\beta\pi(1)(1+r_t)}{Y_{t+1}^o(1) + (1+r_t)B_t^Y - (1+r_t^*)\bar{B}} \\ &+ \frac{\beta\pi(2)(1+r_t)}{Y_{t+1}^o(2) + (1+r_t)B_t^Y - (1+r_t^*)\bar{B}} \quad = 0 \qquad (11)\end{aligned}$$

   Lets call this solution $\hat{\Xi} = (-\bar{B}, \hat{B}_t^Y)$.

The borrower's demand for bonds is given by $\Xi = argmax_{\hat{\Xi},\tilde{\Xi}} EU$.

The financial monopolist maximizes its profits given the young agent's demand for bonds. If it sets domestic interest rate lower than the foreign rate, then in a subgame perfect equilibrium, the young agent's domestic demand for bonds is necessarily positive and vice versa. We may therfore derive his optimal choice as the argmax of the profits from the two cases, one with agent demand given by $\hat{\Xi}$ and the second with agent demand given by $\tilde{\Xi}$. In the third case, when the agent doesn't exhaust her foreign access limits, the monopolist finds it optimal to set $r = r^*$ and we can only determine the agent's total saving or borrowing.

As noted in section 2, except at very high r^* or very low probability of the bad state, the agent's saving supply schedule is upward sloping. For a fall in expected income in the second period, this means that as r^* increases, the agent's savings increase, which means that there is a critical foreign interest rate at which the agent switches from underutilizing her foreign saving limit to being constrained by it. The larger the foreign access limit, the larger this critical foreign interest rate. Furthur, the lower the first period income relative to the foreign borrowing/lending limit, the higher the critical rate (as it means a lower saving supply schedule). Figures 6 and 7 show the results from numerical simulations using the 'fmincon' routine of MATLAB [4]. These confirm that the higher the level of openness, the higher the critical foreign interest rate below which there is interest rate equalization. This implies that during periods of excess liquidity or low global interest rates, as in the first few years of the twenty first century, one would see interest rate convergence, even if the levels

[4]The profit maximization exercise used information from the Kuhn-Tucker conditions to arrive at the solution. The three possible solutions are for the agent to exhaust her saving limit abroad and save at home, or to exhaust her borrowing limit abroad and borrow at home or for total borrowing or saving to be less than the foreign limits in which case the home interest rate equals the foreign rate. The financial institution's profit was maximized in each of these cases over domestic borrowing and interest rate. The solution picked was one in which the agent's choice given the domestic interest rate chosen by the monopolist was the same as the one chosen by the monopolist. Furthur, this exercise was repeated for several initial values of domestic borrowing and interest rate and the solution plotted was one which maximized the profits between these

of de-jure openness remained the same, thus creating conditions conducive to liberalization of the financial sector.

The existence of a critical foreign interest rate below which there is complete elimination of interest differentials also brings in the possibility of sudden shifts in current account balances as the threshold is crossed. Growth in income for example, may make price discrimination for the young generation profitable when it was not profitable for the old generation - leading to a dip in the current account. The current account surplus may be higher with lower global interest rates in a growing economy. The plot of current account in figure 6 below should not be interpeted as the path of current account as r^* falls, but rather the current account when both generations of the economy faced the same r^* shown on the x-axis. This figure then says that in a period of global low interest rates, current accounts maybe larger for the same income and risk profile of both generations. Figure 7 charts the evolution of the current account as the world interest rate falls from 0.15 to 0.1 in period 9. The current account dips for each level of openness, as the old generation's dissaving at time t is determined by their saving at time $t-1$ but the young generation's saving drop because of the lower interest rate.

The simulation results also show that the equilibrium interest rate differential falls with the level of openness. The higher the level of openness therefore, the lower the profits of the domestic financial institution and the lower the revenues from repression. Liberalization of domestic financial sector by increasing the number of intermediaries and opening up of the capital account both reduce revenues from repression and are therefore equivalent from the public finance perspective. In a multi-good version of this model, large expansion of trade would lead to relaxation of capital controls, thus eliminating monopoly profits and undermining the tax-based argument for domestic financial repression.

5 A Test

In this section, the predictions of the model are tested using data on low and middle income countries between 1970 and 2004. The dependent variable is the absolute value of interest differential between country i and the world, computed using nominal deposit interest rates in country i and the 3-month London Eurodollar rate, both measured in percent per annum. The model predicts that this absolute differential is a function of the world interest rate, the lack of competition in the domestic financial market, the level of capital controls, the level of foreign lending, the size of ideosyncratic and macroeconomic shocks (which may themselves depend on the growth rate and level of external market openness). More specifically, it predicts that the absolute interest differential increases with the monopoly power in the domestic financial sector and with the restrictiveness of capital controls. The differential is predicted to decrease with the foreign interest rate if the home interest rate is higher than foreign interest rate and vice versa. The degree of monopoly power in the domestic market is measured by the concentration variable, which is the ratio of assets of three largest banks to the total banking sector assets. Capital controls are measured by the de-jure restrictions (Chinn-Ito (2007) measure) and the de-facto measure by Lane and Milesi-Ferretti (2006) which measures the quantity of cross border flows.

In addition to these variables, I use inflation and growth rates at home and abroad (since the interest rates used are nominal interest rates) as well as the absolute inflation differentials and absolute growth differentials. I also use actual reserve ratio in the banking sector as a proxy of financial repression and two measures of financial depth, the ratio of broad money (M3) to GDP and domestic credit to private sector as pergentage of GDP [5]. The panel data regressions assumed country fixed effects and the standard errors were corrected for heteroskedasticity and cluster-correlation. The results are presented in table 1 below.

The more concentrated the banking assets in a country, the larger the interest differentials between that country and the world market. The effect is significantly different from zero at 5 per cent level in all specifications. Both measures of capital account openness are also significant in explaining the interest differentials. Higher capital account openness reduces interest differentials, as expected. Financial repression as measured by reserve ratios is not significant in explaining the absolute differential between home and foreign interest rates. The positive sign of the financial depth variables is not necessarily contraditory to the predictions of the model. For a given level of banking sector concentration, the larger the market over which the sector exercises its monopoly power, the larger the interest differentials.

[5] See data appendix for furthur details on each of these variables and data sources

6 Conclusions

This paper presented a simple overlapping generations model with financial repression in the form of limited competition in the domestic financial sector coupled with controls on the capital account. The model is able to make interesting and realistic predictions about the real interest differentials and the current accounts. It emphsizes the role of domestic financial development in achieving financial integration (defined as interest convergence) with the rest of the world. It also highlights the role of domestic financial liberalisation and low global interest rates in causing the high current account surpluses in emerging markets in the last decade or so. The model provides a fiscal policy based explanation of the linkages between trade openness and financial openness that have been observed in other studies (Aizenman, 2008; Jinjarak, 2006). Although the model is simple, it makes realistic predictions as seen in the empirical exercise.

The model can be extended in several directions. Allowing for investment in the economy would allow the growth rate to depend on the intermediation activities of the financial institutions and reveal the policy dilemmmas more clearly. Also, allowing for more than one good would explicitly allow trade between domestic and foreign agents and allow one to explore the impact of trade liberalization as distinguished from that of capital account liberalization. Finally the model could easily be reinterpreted as a model of informal sector when access to formal sector lending in an economy is limited and then be used to explore the impact of growth, of liberalization of formal sector and removal of priority lending requirements in the formal sector, on overall financial access and welfare.

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7 Data Appendix

Dependent variable in table 1 is the absolute value of the difference between the nominal deposit interest rate in country i and the 3 month Eurodollar rate, both expressed in eprcent per annum and sourced from International Financial Statistics (IFS) database of International Monetary Fund (IMF). Concentration is the ratio of the assets of three largest banks to the total banking sector assets, with peak concentration ratio equal to 1 (Source: World Bank). Inflation_gdp is the domestic inflation measured by GDP deflator from World Development Indicators (WDI). Abs(Inflation_diff) is the absolute value of difference between domestic inflation (GDP deflator) and inflation in the US (Source: WDI). Reserve Ratio is the ratio of total liquid reserves to assets ratio for the banking sector expressed as a percentage, a proxy for required reserve ratios (Source: WDI). GDP growth is in percent per annum and is from WDI. Abs(GDP Growth_Diff) is the absolute value of domestic GDP growth and that of US. M3 (% of GDP) is the ratio if broad money to GDP and DomCrPvtZgdp is the domestic credit to private sector, in percent (Source: WDI). These are two proxies for financial depth. KAopen_LMF is the Lane Milesi-Feretti (2006) index of capital openness (sum of external assets and liabilities over GDP, expressed as a percentage). KAopen_CI is the Chinn-Ito (2007) index of de-jure capital account openness.

Table 1. Absolute Domestic - Foreign Interest Differential and Bank Concentration

	(1)	(2)	(3)	(4)
Eurodollar3m	-0.268*	-0.315**	-0.280*	-0.296*
	(0.144)	(0.150)	(0.150)	(0.156)
Concentration	6.234**	7.194**	7.795**	8.557**
	(3.117)	(3.242)	(3.376)	(3.463)
Inflation_gdp			0.253***	0.255***
			(0.0555)	(0.0537)
Inflation_gdp_US			-1.005**	-0.954**
			(0.467)	(0.456)
M3 (% of GDP)	0.0316		0.0162	
	(0.0314)		(0.0317)	
KAopen_CI	-1.211***	-1.293***	-1.193***	-1.253***
	(0.325)	(0.325)	(0.347)	(0.345)
KAopen_LMF	-0.0236**	-0.0241***	-0.0249***	-0.0255***
	(0.00923)	(0.00891)	(0.00892)	(0.00858)
Reserve Ratio	0.00323	0.0152	0.00751	0.0154
	(0.0254)	(0.0251)	(0.0247)	(0.0249)
GDP Growth			-0.281***	-0.263***
			(0.0590)	(0.0589)
GDP Growth (US)			-0.403***	-0.424***
			(0.135)	(0.135)
abs(Inflation_gdp_diff)	0.284***	0.284***		
	(0.0600)	(0.0586)		
abs(GDP_gr_diff)	0.110	0.0987		
	(0.107)	(0.103)		
DomCrPvtZgdp		0.0702**		0.0563**
		(0.0276)		(0.0283)
Constant	3.827	2.364	8.487***	6.721**
	(2.727)	(2.585)	(2.898)	(3.006)
Observations	872	872	872	872
Number of coden	94	94	94	94
R^2	0.322	0.329	0.345	0.350

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Observations include all observations for Middle and Low income countries (WB classification) for which deposit rates and GDP deflator inflation rates were less than 100% per annum and bank reserve ratios less than 100%. Fixed effects estimator with standard errors that allow for heteroskedasticity and cluster-correlation.

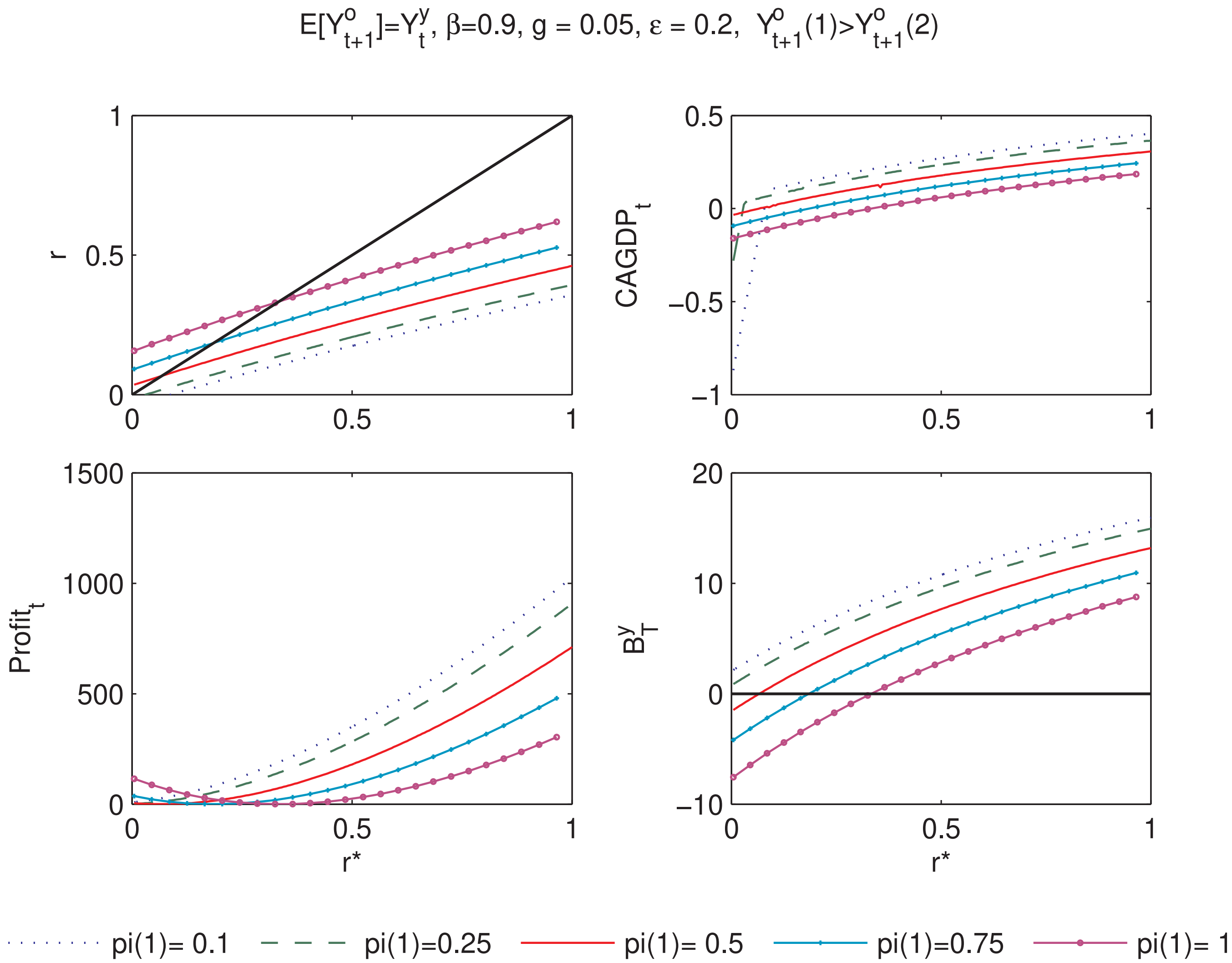
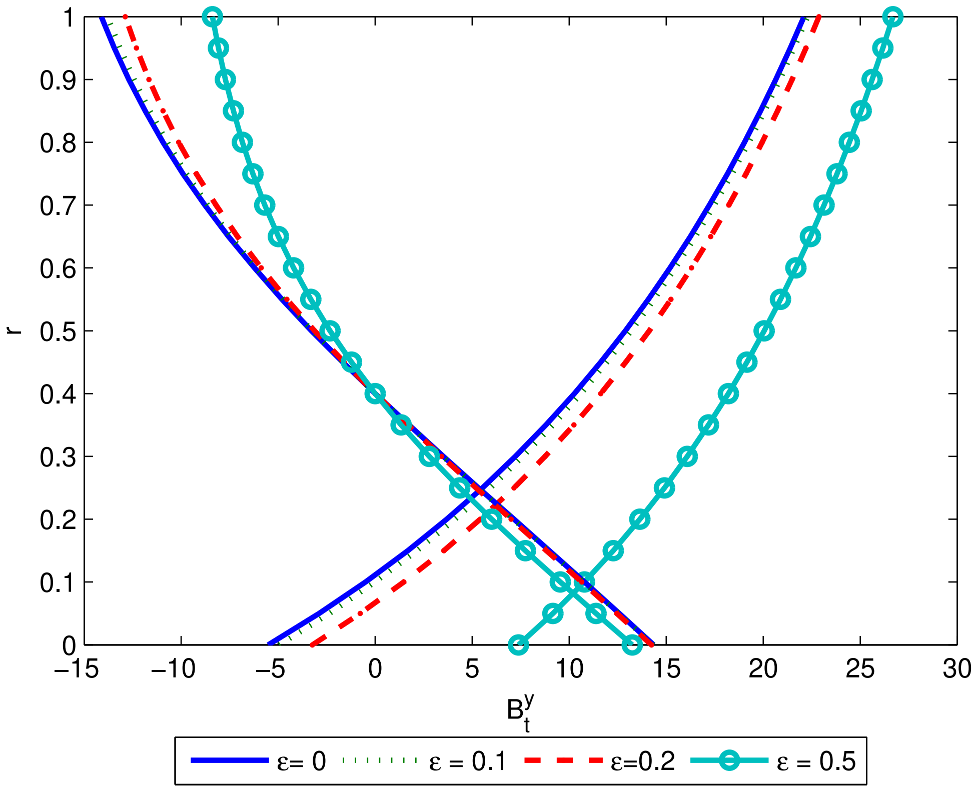
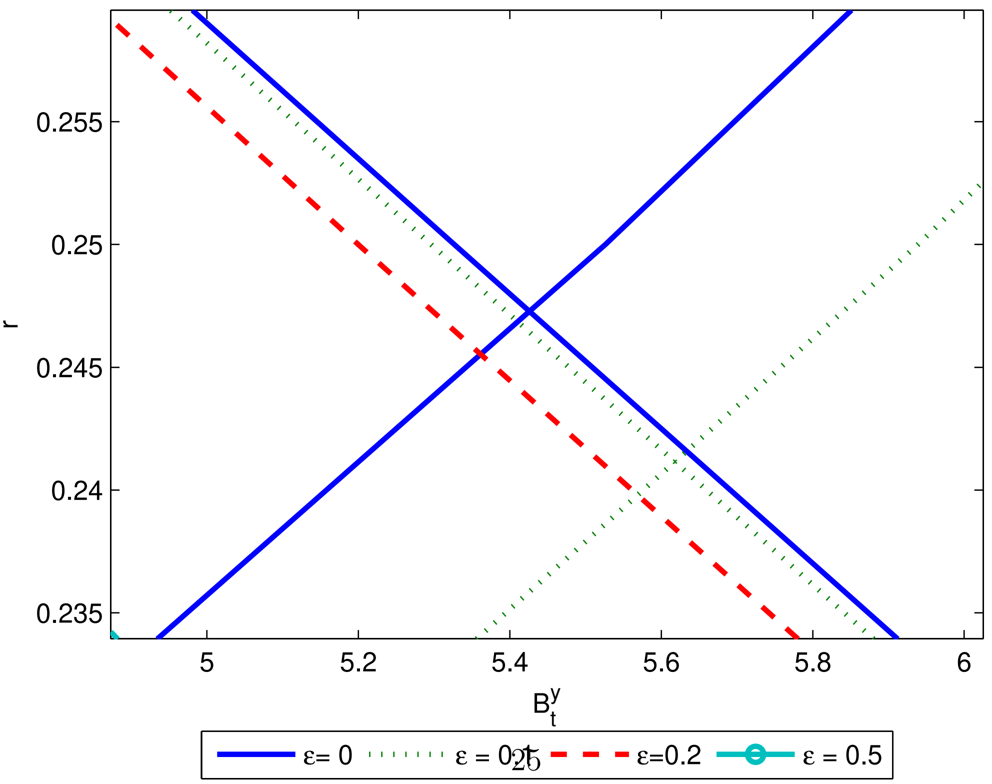


Figure 1: Variation in $\pi(1)$, probability of good state. The figure plots the home interest rate in period t, r, the Current Account as percentage of GDP in period t ($CAGDP$), the profits of the domestic financial sector ($Profit_t$) and the domestic saving by the young generation in period t as a function of period t foreign interest rate, r^* for different values of the probability of good state, $pi(1)$. $Y^Y_{t-1} = 100$, $GDP_t = Y^Y_t + Y^o_t$.



(a)



(b) Enlarged Section

Figure 2: Supply of Saving and Monopolist's Best Response Functions, $g = 0.5, \pi(1) = 0.5, \beta = 0.9, r^* = 0.4$. Downward sloping curves are the agent's demand for domestic bonds and the upward sloping curves the Monopolist's best response functions for different values of the ideosyncratic shock.

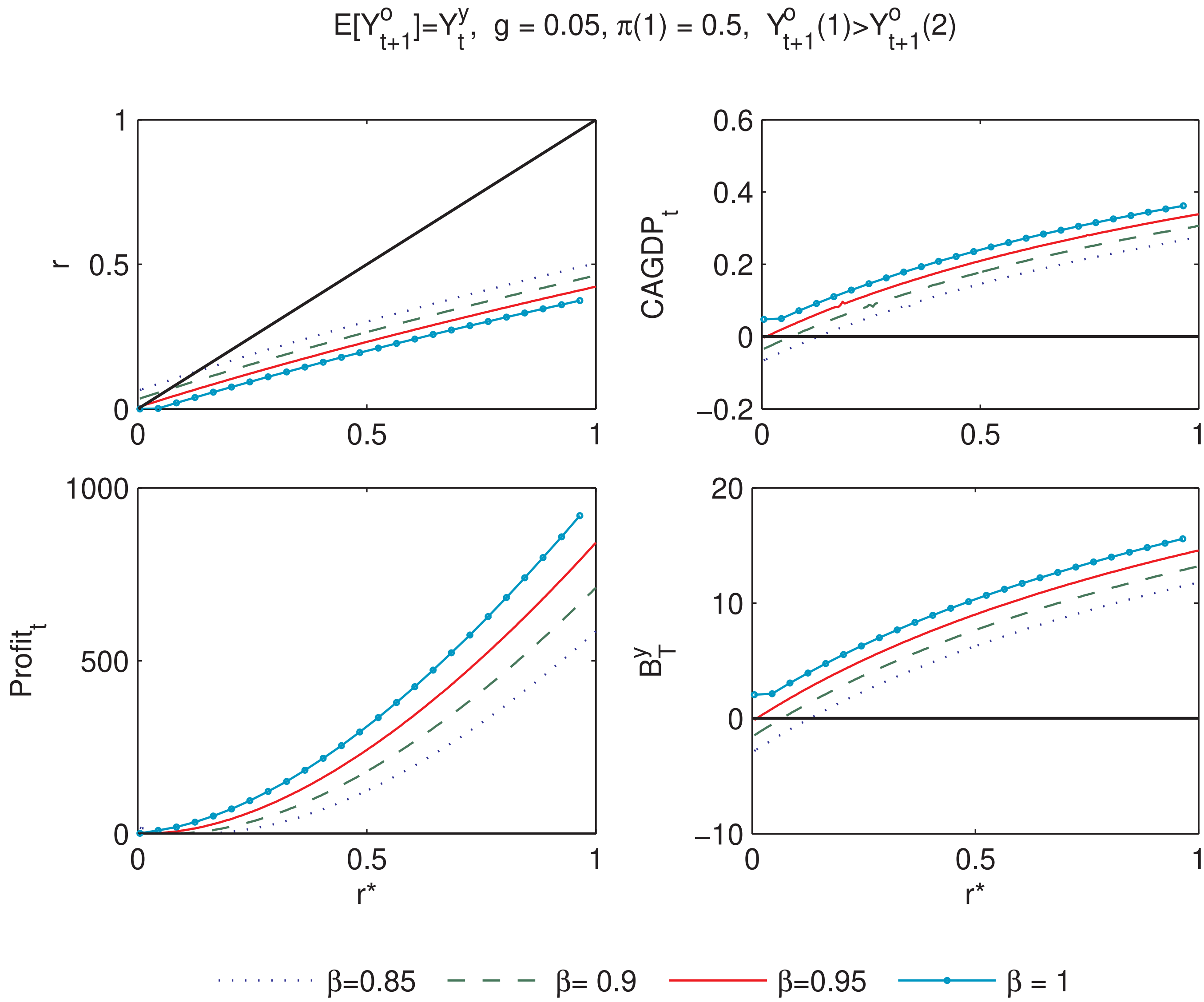


Figure 3: Variation in β. The figure plots the home interest rate in period t, r, the Current Account as percentage of GDP in period t ($CAGDP_t$), the profits of the domestic financial sector ($Profits_t$) and the domestic saving by the young generation in period t as a function of period t foreign interest rate, r^* for different values of the discount factor, β. $Y_{t-1}^{Y} = 100$, $GDP_t = Y_t^Y + Y_t^o$.

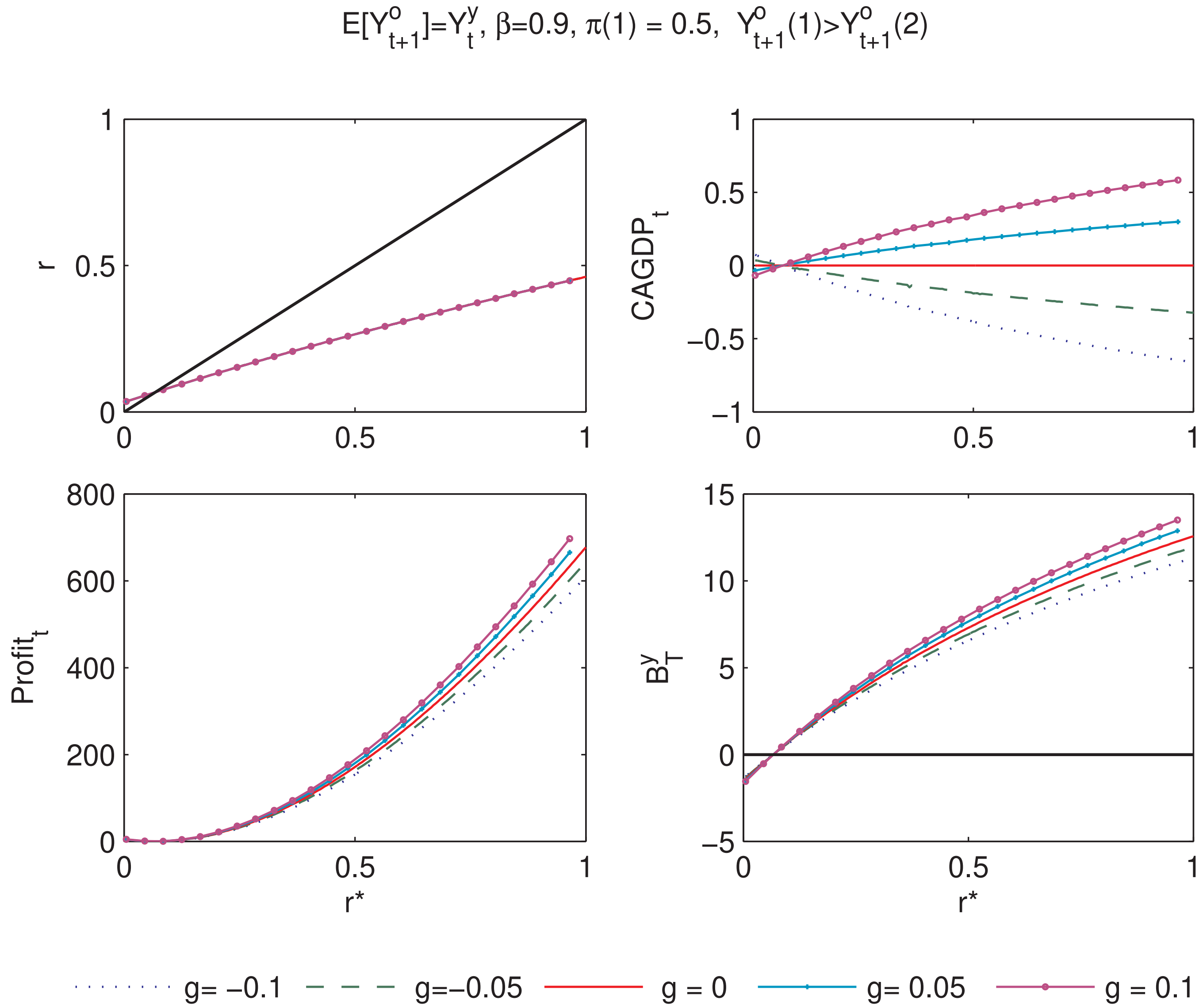


Figure 4: Variation in Growth Rates. The figure plots the home interest rate in period t, r, the Current Account as percentage of GDP in period t ($CAGDP$), the profits of the domestic financial sector ($Profits_t$) and the domestic saving by the young generation in period t as a function of period t foreign interest rate, r^* for different values of the growth rate, g. $Y^Y_{t-1} = 100$, $GDP_t = Y^Y_t + Y^o_t$.

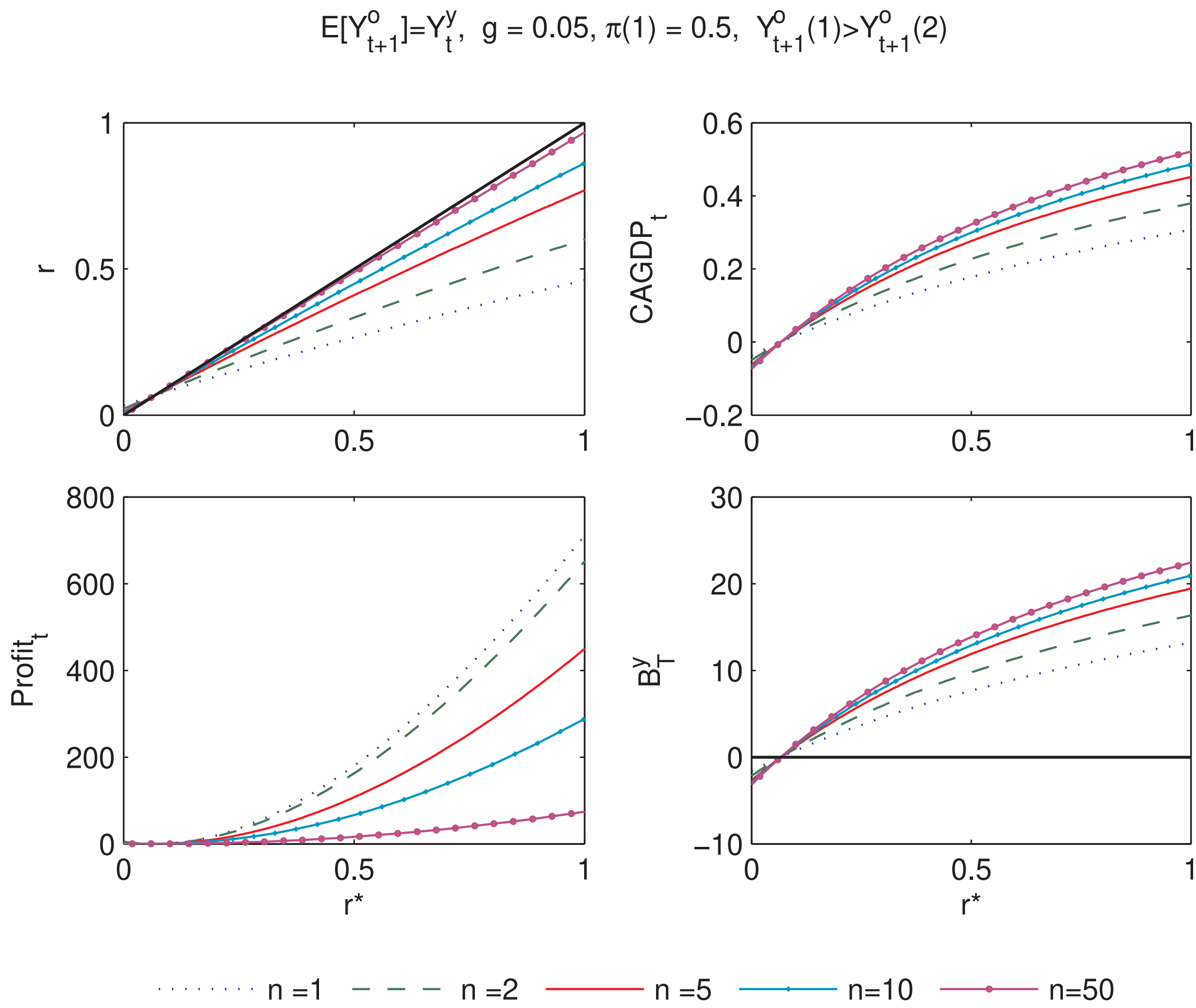


Figure 5: Variation in Number of Financial Institutions. The figure plots the home interest rate in period t, r, the Current Account as percentage of GDP in period t ($CAGDP$), the total profits of the domestic financial sector ($Profit_t$) and the total domestic saving by the young generation in period t as a function of period t foreign interest rate, r^* for different number of domestic financial institutions. $Y^Y_{t-1} = 100$, $GDP_t = Y^Y_t + Y^o_t$.

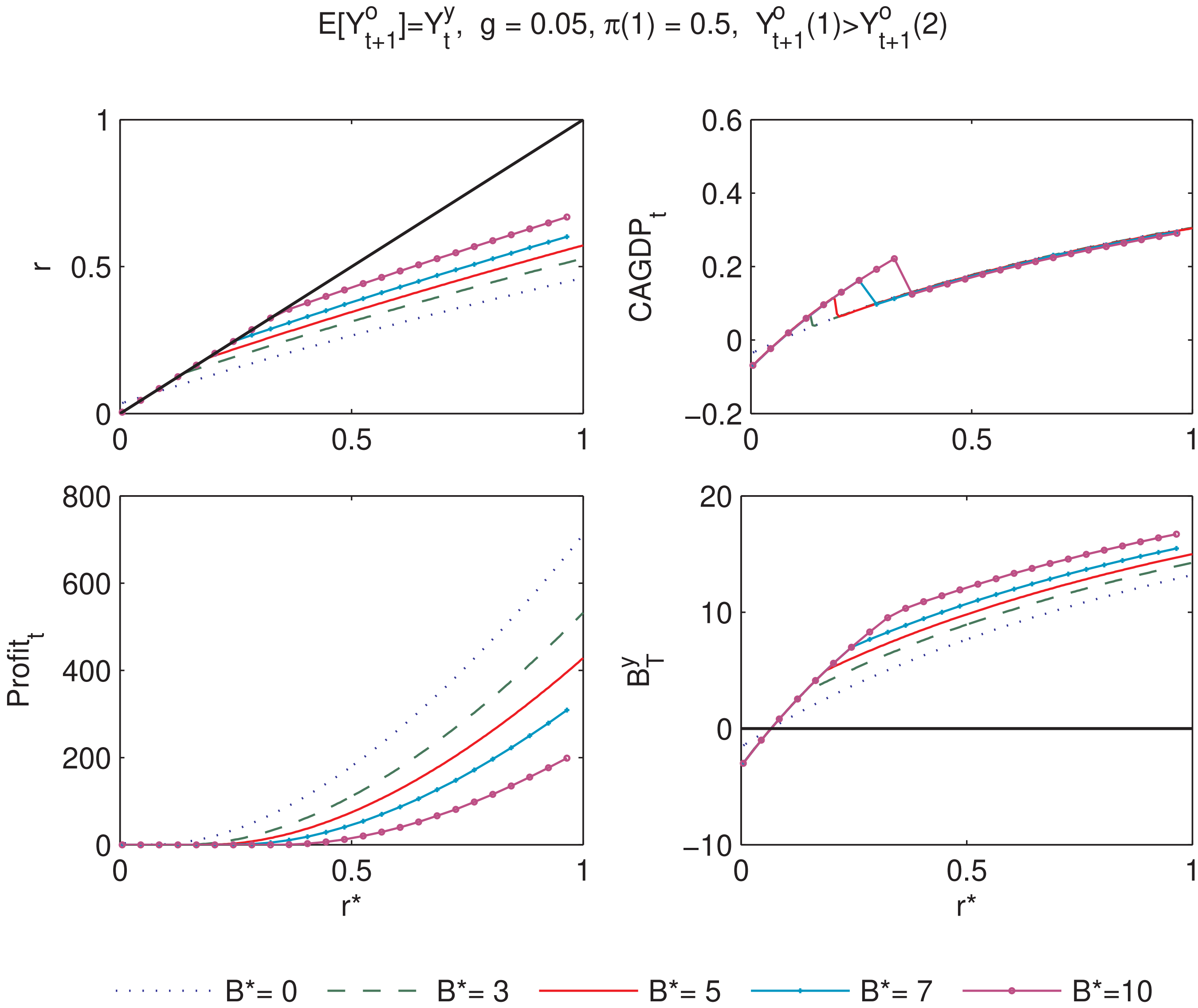


Figure 6: Agent Access to Foreign Markets. The figure plots the home interest rate in period t, r, the Current Account as percentage of GDP in period t ($CAGDP_t$), the profits of the domestic financial sector ($Profit_t$) and the total saving by the young generation in period t when both generations face the same foreign interest rate, r^*, plotted on the x-axis, for different values of the foreign borrowing and lending limit, B^*. $Y^Y_{t-1} = 100$, $GDP_t = Y^Y_t + Y^o_t$.

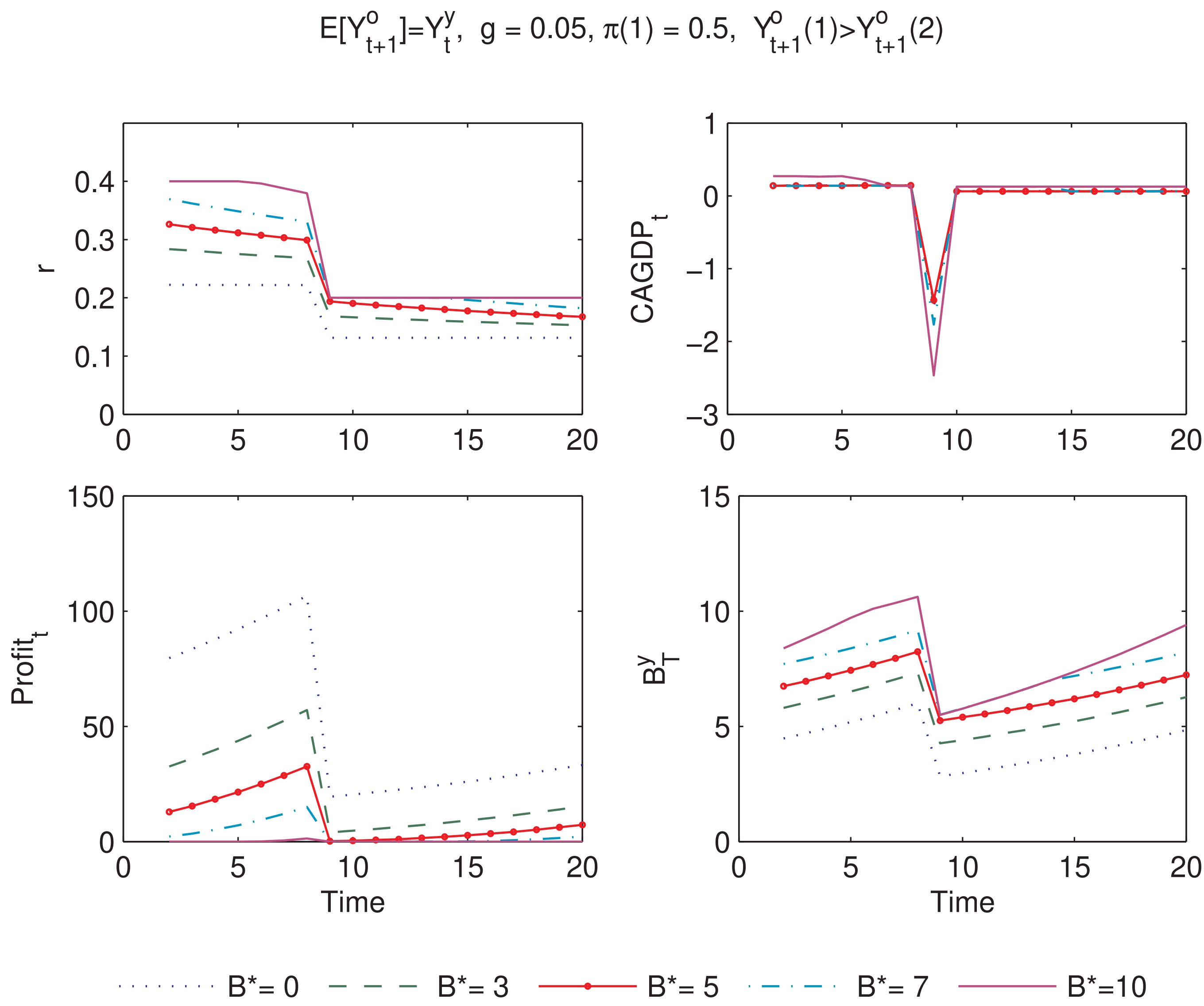


Figure 7: Dynamics of a Fall in Foreign Interest Rate. The figure plots the home interest rate, r, the Current Account as percentage of GDP, $CAGDP$, the profits of the domestic financial sector (Profit) and the domestic saving by the young generation over time as foreign interest rate falls from 0.4 in periods 0 to 8 to 0.2 in period 9 and stays there. GDP in time t equals $Y_t^Y + Y_t^o$.